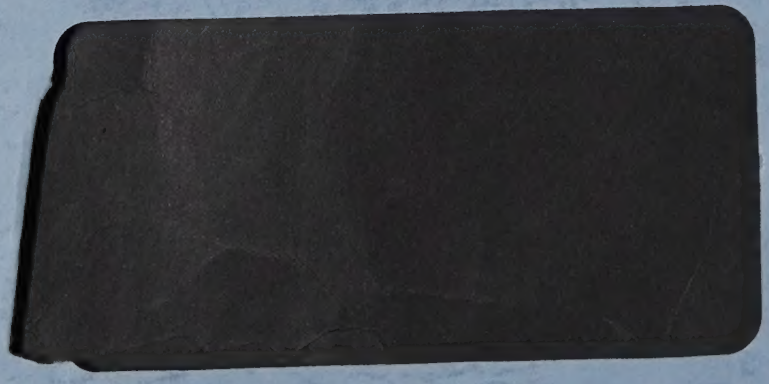
INSTRUCTION MANUAL

SOLTEC

VP-6723S

2-pen Portable Recorder



INSTRUCTION MANUAL

SOLTEC

VP-6723S

2-pen Portable Recorder

Before operating this set, please read these instructions completely

Soltec Corporation
11684 Pendleton Street
Sun Valley, California 91352

Tel. (213)767-0044 Telex 67-4188

Digitized by the Internet Archive
in 2025

https://archive.org/details/manualsplus_07242

CONTENTS

		Page
Section 1.	Specifications	1 - 1
Section 2.	Operating Instructions	2 - 1
Section 3.	Adjustment	3 - 1
Section 4.	Maintenance	4 - 1
Section 5.	Parts List	5 - 1
	Schematic Diagrams	

1.2 Specifications

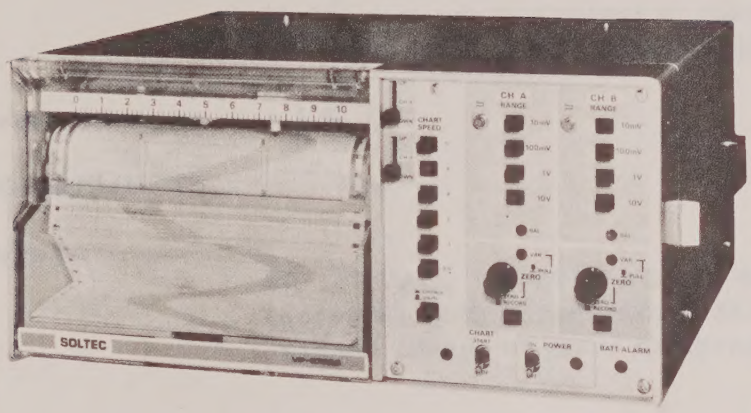
INPUT

Measuring system:	Null balance potentiometric DC servo system
Input spans:	10, 50, 100, 500 mV, and 1, 5, 10, 50 V for full scale in eight calibrated ranges
Input overload:	100 V DC for 10 mV to 500 mV ranges 300 V DC for 1 V to 50 V ranges
VAR control:	Frontpanel-adjustable with a screwdriver, provides continuously variable span between input ranges and up to 100 V (Factory-set at 1/5)
Input impedance:	1 Megohm on all ranges
Source impedance:	10 kilohms maximum on all ranges
Frequency response:	DC to 1 Hz for 100 % full span DC to 1.5 Hz for 66 % full span
Accuracy:	$\pm$ 1 % of full span (fixed ranges) $\pm$ 2 % (VAR)
Linearity:	$\pm$ 0.5 % of full span (at 1 V range)
Dead band:	$\pm$ 0.5 % of full span
Temperature drift:	20 μV/°C
Zero adjustment:	Continuous zero adjustment over full span, 0 to 100 % with a single-turn potentiometer Zero check switch provided

PEN & CHART

Writing system:	Disposable feltpen Red (VQ-061R05) for Channel B and Black (VQ-061K15) for Channel A
Pen lifter:	Manual pen lift provided for each channel
Glitch marker:	Manual provided for each channel
Writing speed:	250 mm/sec, approx. 0.5 sec full scale

Section 1. SPECIFICATIONS



1.1 General Description

The Model VP-6723S is a battery/DC/AC powered portable strip chart recorder, and features continuously variable input spans from 10 mV to 100 V, twelve chart speeds from 16 cm/min to 0.5 cm/hr, wide recording span of 120 mm, disposable feltpen writing system, built-in battery charger, 0.5 sec full scale pen speed, glitch marker pushbutton and 50 mV voltage calibrator.

The input spans are pushbutton-selectable from four calibrated ranges of 10 mV to 10 V. The pull-switch attenuator concentric with the ZERO control provides an additional four ranges from 50 mV to 50 V. The screwdriver-adjustable VAR control offers continuously variable spans up to 100 V. The 50mV calibrator is convenient for quick span calibration, eliminating the need to connect an external standard calibrator.

The chart speed is selectable from twelve ranges of 16 cm/min to 0.5 cm/hr. The rearpanel CHART DRIVE jack gives external chart speed control capability with external pulse train.

Chart:	120 mm calibrated width Z-fold chart 10 meters long, 37.5 mm folds
Chart speeds:	0.5, 1, 2, 4, 8, 16 cm/min and cm/hour in 12 calibrated speeds External chart drive is available through rearpanel jack. (0.025 mm per two pulses at chart speed of 16 cm/min, TTL level, 300 p/sec or less)
Chart speed accuracy:	± 1 %

POWER REQUIREMENTS

Supply voltage:	90-127 VAC, 198-253 VAC, 50-400 Hz (accepts any line frequency in the range without change of gears or sprocket.)
Power Consumption:	Approx. 15 VA in balanced condition Approx. 20 VA in unbalanced condition
Internal Battery:	12 V (1.5 V x 8) Eight manganic, alkaline or rechargeable Ni-Cd batteries of 3.5 ampere hour capacity Probable operation time is 5 hours using manganic batteries, or 8 hours using alkaline or Ni-Cd batteries for input signal of 0.01 Hz sinewave and chart speed of 4 cm/hour. Full charge requires approx. 15 hours with internal charger.
External Battery:	12 VDC (11 to 15 V) and 24 VDC (22 to 30 V)
DIMENSIONS & WEIGHT	130(H) x 280(W) x 230(D) mm Approx. 6 kg with batteries
STANDARD ACCESSORIES	HVP-12-1Z-10, Z-fold chart VQ-061R05 red feltpen VQ-061K15 black feltpen EXT chart control plug

Section 2 OPERATING INSTRUCTIONS

2.1 Operating Cautions

1. POWER SOURCE switch for power supply

Set the POWER SOURCE switch (18) on the rear panel to a position corresponding to power being used.

For AC power supply, do not fail to set the POWER SOURCE switch (18) to AC LINE position.

Usable power sources

①	AC LINE	Nominal AC voltage ± 10%, 50 - 400 Hz
②	INT BATTERY	1.5 V battery x 8 Alkaline batteries, Manganese batteries, or rechargeable Ni-Cd batteries
③	EXT BATTERY	For external batteries 12 V range: 11 - 15 V (approx. 1 A) 24 V range: 22 - 30 V (approx. 0.6 A)

Battery life

When a 0.01 Hz sinewave signal is applied to the input terminals and the chart speed is set to 4 cm/h, the battery life at a deflection of 90% or more of full scale will be approx. 8 hours for alkaline or Ni-Cd batteries and approx. 5 hours for manganese batteries with continuous use. When the battery voltage drops, the battery alarm LED (14) lights up, and the batteries should be replaced. When only one pen is used and the POWER SAVING switch (17) is set to "CH-A only", continuous for 12 hours or longer is possible for alkaline as well as manganese batteries.

Diagrams for battery life and charging are shown in Fig. 2-9 and Fig. 2-10.

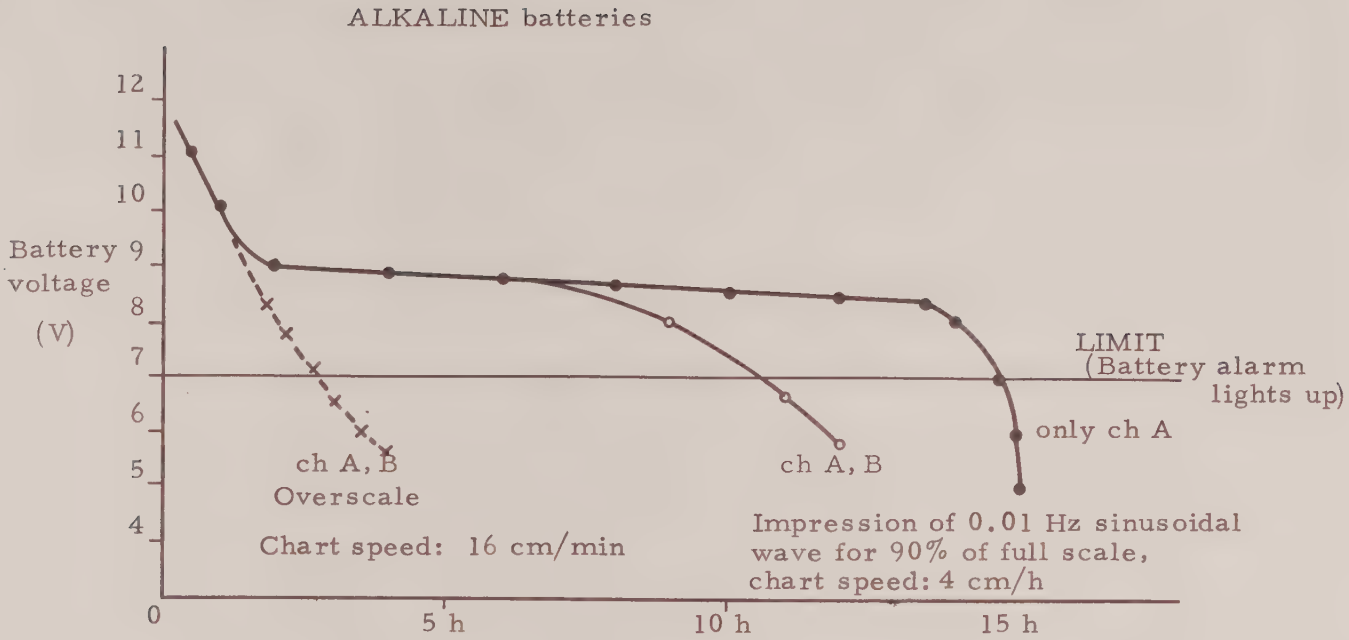


Fig. 2-9 Battery life

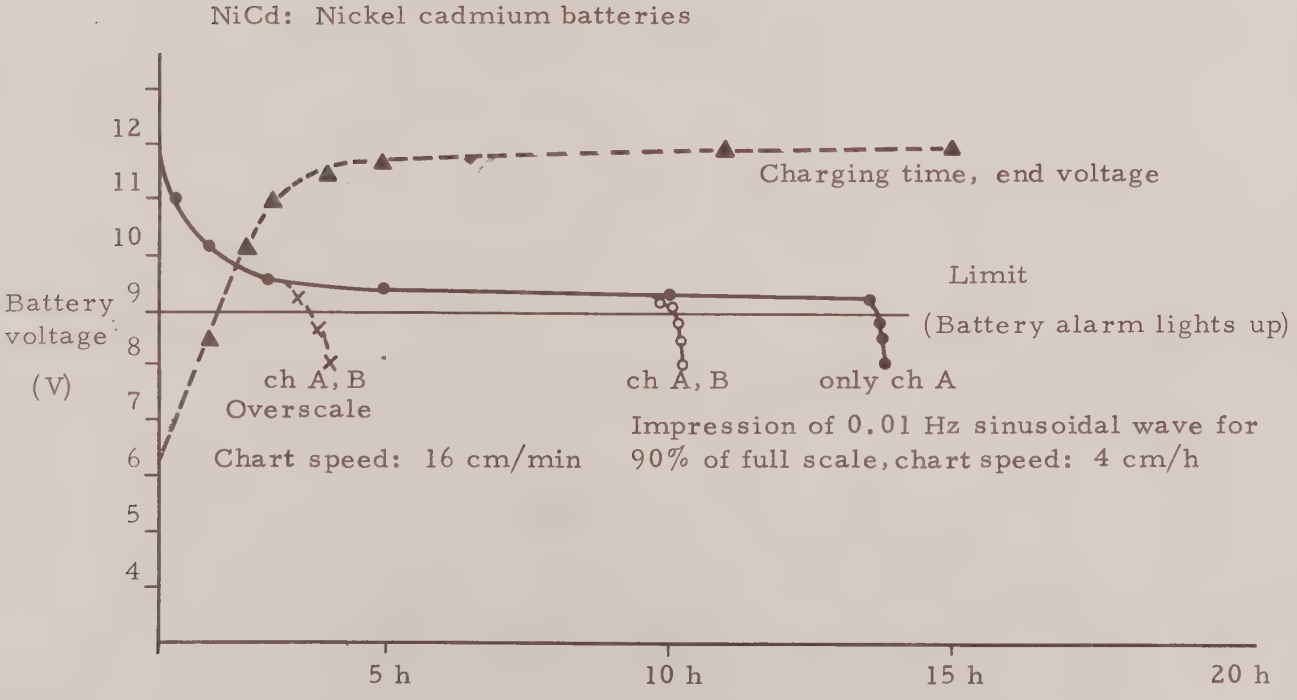


Fig. 2-10 Battery life and charging characteristic

2. Warm-up time

For stable operation, allow warm-up time of 30 minutes or longer. Otherwise, zero position is liable to shift when RANGE setting (5) is changed.

3. Zero adjustment

Before supplying power, set the RANGE switch (5) to the desired span, and depress ZERO-RECORD switch (9) to ZERO position.

Then set POWER toggle switch (10) to ON, the green LED shall glow.

Rotate the ZERO control (8). Verify that pen moves over the full span.

4. Recording chart

The amount of unused chart can be calculated approximately by the following equation:

Unused chart = 10 cm x the number indicated in the right edge of chart

For consistent chart fold, operation under humid conditions (RH 80% or higher) is not recommended.

5. Internal battery charger

Do not try to charge non-rechargeable manganic or alkaline batteries. This may result in degradition of batteries or explosion.

6. Internal buzzer

The internal buzzer warns for excessive external DC power supply only when the POWER SOURCE selector (18) is set in 12 V position.

7. External pulse control

1) For external pulse control of the recording paper feed, wire the accessory plug and insert it into the external pulse connection jack (23). Impress a rectangular wave of TTL level as control signal. Under the following conditions, 2 external pulses advance the paper for 0.025 mm.

Chart speed selector switch ..... (16 cm)

cm/min·cm/h selector switch ..... (cm/min)

2) As this circuit uses the method of switching by plug insertion from the built-in oscillation circuit to the external oscillation circuit, the range selector switch is coupled. Setting to 8 cm/min provides 0.025 mm paper advance by 4 pulses.

3) As insertion of the accessory plug automatically switches to external pulse control, the plug should be pulled out when external pulse control is not used.

8. Marker push button

When the CAL/RECORD change-over switch is set to (RECORD), marker superposition over the recording curve is obtained by pushing the marker push button (4).

Note: When the marker push button is pushed with the setting CAL, it swings widely to the left, which is normal.

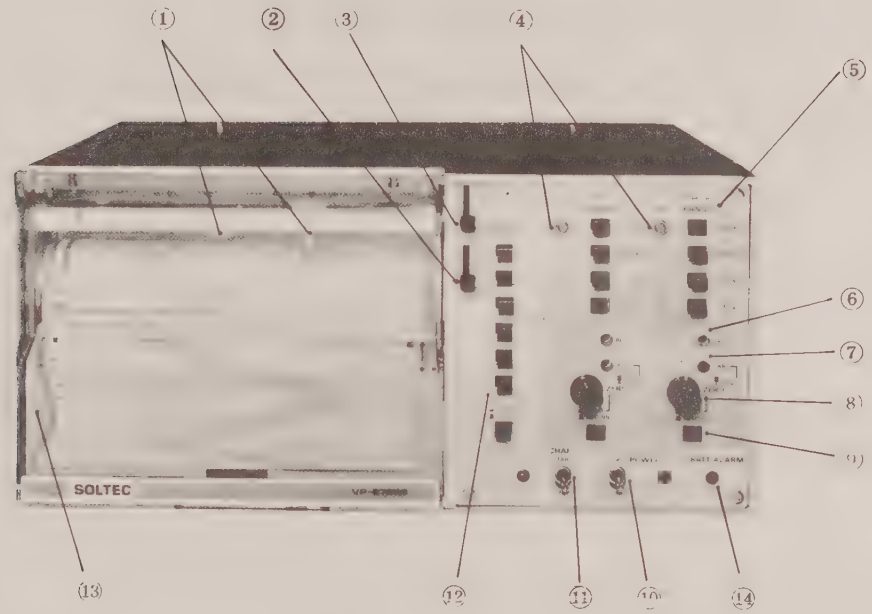
9. Others

1) As resin mold is used for mainframe and other parts of this instrument, avoid touching with hot soldering irons etc.

2) With manual recording paper feed during recording paper feed, the recording paper feed slightly stops, but this is only the delay of the gear engagement and no abnormality.

2.2 Description of Controls and Connectors

2.2.1 Frontpanel Controls and Connectors



① Feltpen writing system: Long-life disposable pens allow clear accurate recording. Probable life of pen is approx. 700 meters in continuous recording distance.

Red pen (VQ-061R05) is used in channel B (CH B) and black pen (VQ-061K15) in channel A (CH A).

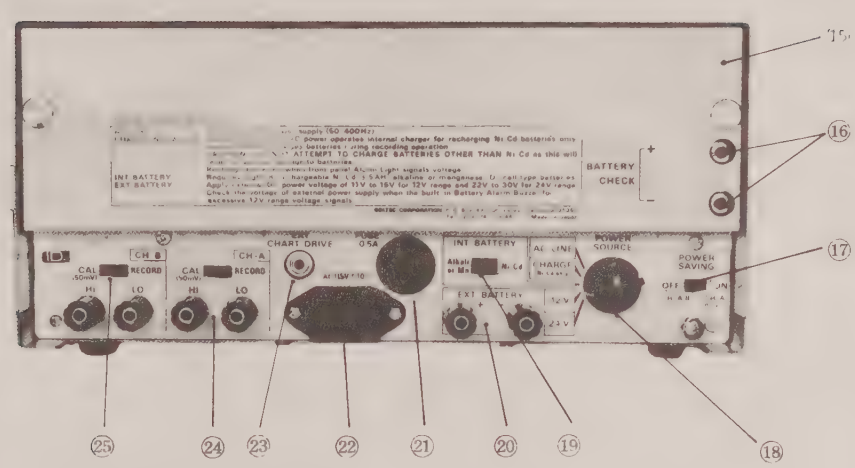
② Pen lifter: Manual pen lift for red pen (CH B)

③ Pen lifter: Manual pen lift for black pen (CH A)

④ Event marker pushbutton: Used to make markings during recording for simplicity of data analysis.

(5) RANGE pushbutton switch:	Selects calibrated ranges of 10 mV, 100 mV, 1 V and 10 V or 50 mV, 500 mV, 5 V, and 50 V with ZERO knob pulled out.
(6) BAL control:	Used to minimize pen shift when RANGE setting is changed.
(7) VAR control:	With ZERO adj control (8) pulled out, full scale span can be adjusted for any span setting within 10X the RANGE selected.
(8) ZERO control:	Allows adding an offset voltage to the input of up to 100% of the RANGE selected. Pulling this outmultiplies selected RANGE by five.
(9) ZERO/RECORD pushbutton:	Cuts off the input signal to recorder for zero check with button "in".
(10) POWER ON/OFF switch:	Switch to power the recorder from AC line voltage, internal batteries, or external DC power supply.
(11) CHART START/ STOP switch:	The LED to the left of the CHART switch glows. When in START position.
(12) CHART SPEED pushbutton selector:	Used to set chart speed in twelve ranges of 16 cm/min to 0.5 cm/hour
(13) Chart magazine:	Plastic cassette chart magazine
(14) BATT ALARM LED:	Glows for the need of replacement of internal batteries or recharge of Ni-Cd batteries

2.2.2 Rearpanel Controls and Connectors



(15) Battery compartment: Eight batteries are mounted in this compartment. The two screws securing the rear plate are removed for access to batteries.

(16) BATTERY CHECK terminal: Used to check output voltage of internal batteries

(17) POWER SAVING switch: Used to save power for single channel recording. Set this switch in the ON position (CH A only) for power saving, and in the OFF position for dual channel recording.

(18) POWER SOURCE selector: Set this switch to a position corresponding to power supply source.

(19) INT BATTERY selector: When instrument is powered from internal Ni-Cd batteries, set selector to the "Ni-Cd" position.

(20) EXT BATTERY terminal:	Used to connect external DC power supply
(21) FUSE 0.5A:	Replaceable fuse for AC operation only
(22) AC 115V ±10% connector:	Connector for AC operation
(23) EXT CHART DRIVE connector:	Used to connect external pulse for external chart speed control. For normal operation, remove the EXT chart drive plug supplied as a standard accessory.
(24) CH-A and CH-B input terminals:	Used to connect input signals. When a positive voltage is applied to the HI terminal, the pen moves toward the right.
(25) CAL/RECORD switch:	Despite the connection of input signals, the CAL position provides 50 mV calibrated voltage to the instrument. For normal recording, set this switch to RECORD position.

2.3 Operating Instructions

2.3.1 Chart Paper Mounting and Replacement Procedure

1) Lightly push the top edge of the cover as shown in Fig. 2-3 and open the front cover.

Fig. 2-3 Opening of the front cover

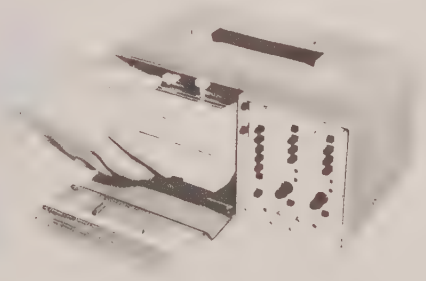


Fig. 2-4 Pulling out of the chart magazine

2) Open the front cover as shown in Fig. 2-4, lift up the pen, and use the projection on the chart magazine (near the center at the bottom of the magazine) to pull the magazine upwards. When the magazine is raised as shown in Fig. 2-4 at a nearly right angle, it can be pulled out to the front.

3) Remove the magazine as shown in Fig. 2-5 and insert a recording paper into the recording paper holder on the rear. Insert a recording paper with the square feed holes on the left and the rectangular feed holes on the right and warp the printing surface slightly upwards.

Fig. 2-5 Recording paper insertion (1)

4) Take out the edge of the recording paper as shown in Fig. 2-6 and make triangular cuts on both corners. Pass the paper underneath the holding bar and feed it manually until the edge of the recording paper comes out on the other side.

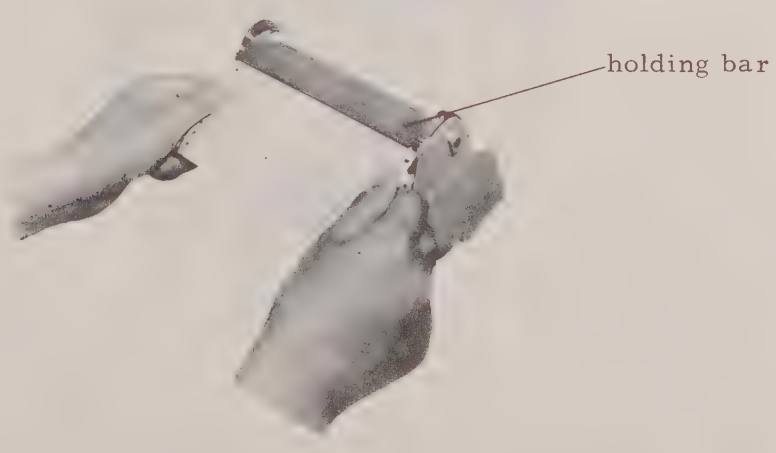


Fig. 2-6 Recording paper insertion (2)

5) Reverse the magazine as shown in Fig. 2-7 (front), lift the holding bar, pull out the recording paper, and adjust it so that the recording paper feed holes become parallel to the sprocket. Then lower the holding bar, feed with the gear on the right side, and fold for 2 or 3 folds.

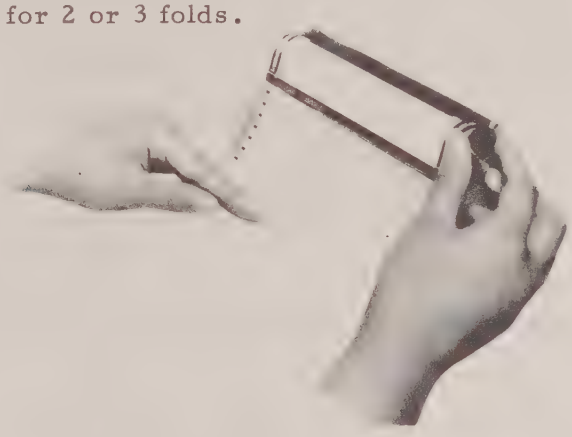
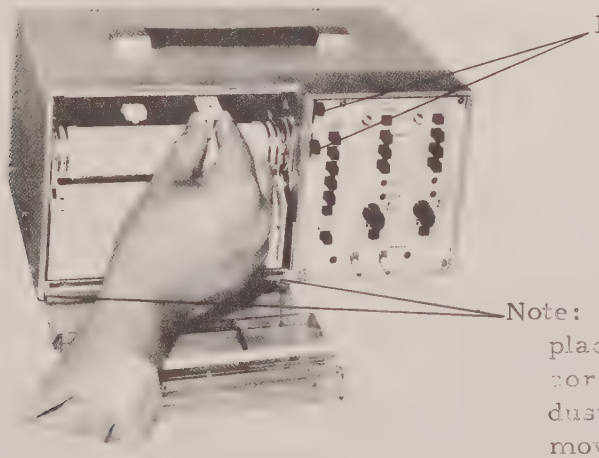


Fig. 2-7 Recording paper insertion (3)

6) Execute insertion of the chart magazine in the reverse order of removal.

2.3.2 Pen Mounting Procedure

Install the pens. As shown in Fig. 2-8, remove the cap of the felt pen and insert it into the holder until it stops. Use the pen lifter (2) and (3) on the left side of the panel for pen lift UP/DOWN.



Note: Pen tip covers are placed at the bottom corners of the front dust cover when removed for recording, as shown in the figure in the left, lest they are lost.

Fig. 2-8 Pen Mounting

2.3.3 Balance Adjustment

* Warm up recorder for 30 minutes or longer for accurate adjustment.

1) Depress ZERO check pushbutton switch to ZERO position.

2) Select 100 mV on RANGE switch.

3) Then, select 10 mV on RANGE switch and adjust "BAL" adj control so that pen position in 10 mV range coincides with that in 100 mV range.

Note: During adjustment, do not turn ZERO adj knob (8).

2.3.4 Variable Adjustment (VAR)

For variable input span setting, pull out ZERO adj knob (8).

With rearpanel 50 mV CAL, four calibrated input spans of 50 mV, 500 mV, 5 V and 50 V are available by the following procedure.

1) Push in ZERO/RECORD pushbutton (9) to ZERO position, and pull out ZERO adj control knob (8).

2) Set RANGE pushbutton to 100 mV range.

3) By rotating ZERO adj knob (8), set pen to Scale 0 position on the left of chart and make recording.

4) Switch rearpanel CAL-RECORD selector (25) to CAL position.

5) Set ZERO/RECORD pushbutton (9) to RECORD position, and note that pen moves to the right.

6) Adjust VAR control (7) with a screwdriver so that pen is set to Scale 1 position on the left of chart.

7) Then, set input range to 10 mV, and adjust VAR control minutely so that pen is set to Scale 10 position on the right edge of chart.

Note: For more accurate span setting, use an accepted voltage standard.

2.3.5 Instructions for Ni-Cd Battery

1) Ni-Cd Battery Operation

(1) "POWER SOURCE" switch must be in "INT BATTERY" position and slide switch must be on "Ni-Cd".

(2) "BATT ALARM" light will come ON when battery voltage is low (8.8 V for Ni-Cd).

2) Ni-Cd Recharge Operation

(1) Put both channels in "ZERO" mode ("ZERO/RECORD" pushbutton IN) so pens will not drift off-scale while recharging.

(2) Place both pens in center area of recording surface (to prevent being off-scale).

(3) Raise both pens (with pen "UP" lever) and remove pens. (If pen tip covers are on pens, pens cannot pass one another and may result in overheating.)

(4) "POWER SOURCE" switch (on back of recorder) must be in "CHARGE" position. "INT BATTERY" slide switch must be in "Ni-Cd" position.

(5) Put "POWER" switch (on front of recorder) in "ON" position.

(6) The "BATT ALARM" light (on front of recorder) will be ON while recharging, until Ni-Cd battery voltage reaches 11.5 V. The light should then go out.

(7) DO NOT CHARGE FOR MORE THAN 15 HOURS (or batteries may be damaged).

3) AC Operation While Recharging Ni-Cd Batteries

(1) "POWER SOURCE" switch (on back of recorder) must be in "CHARGE" position. "INT BATTERY" slide switch must be in "Ni-Cd" position.

(2) Put "POWER" switch (on front of recorder) in "ON" position.

(3) The "BATT ALARM" light (on front of recorder) will be ON while recharging, until Ni-Cd battery voltage reaches 11.5 V. The light should then go OUT.

(4) Normal recording (using AC power) may be done while charging Ni-Cd.

2.4 First-time Operation

1) Set the chart magazine.

2) Set the chart START-STOP switch to STOP.

3) Set the pen lifter (UP/DOWN lever) to UP.

4) Set the ZERO-RECORD switch to ZERO.

5) Set the POWER SOURCE switch (18) on the rear to the used power source.

6) When the POWER SOURCE switch (18) is set to AC LINE, connect the power cable to the AC power source. The power source voltage is shown on the rear panel.

7) Set the POWER switch (10) to ON.

8) Use the ZERO knob (8) to set the pen to an optional position.

9) Select the desired chart speed.

10) Set the RANGE switch (5) according to the input signal.

11) Set the CAL/RECORD change-over switch (25) on the rear panel to RECORD.

12) With chart START, pen DOWN, and ZERO-RECORD switch to RECORD from the above condition, measuring and recording of phenomena is possible.

*Note

Pen DOWN and chart START without recording paper cause damage or abnormal wear of the pen.

Section 3 ADJUSTMENT

1. Required test instruments and tools

Standard voltage generator	
Stopwatch	Time measurement ca pability up to 30 minutes with minimum graduation of 0. 1 sec
Tension gage	110 g
Torque gage	1 kg - cm
Regulated DC power supply	12 V
Line voltage adjustor	150 V, 1A
Insulation Tester	
AC Voltmeter, current meter	AC 150 A, 15 V, 0. 1A, 0. 5A
Voltage Tester	
Digital voltmeter	Resolution of 50 μV or better
Frequency counter	

2. Cautions

(1) Keep sliding portions and gears from chips during adjustment.

(2) "Direction" is referred to a position that the pen is at the operator side.

(3) The following requirements should be observed during adjustment unless otherwise specified.

1) Power requirement: AC 115 V ±2 V, 60 Hz ±0. 5 Hz

2) Ambient temperature: 20° C ±2° C

3) Warm-up time: 30 minute or more after switch on

3. Adjustment

3-1 Pen drive mechanism

(1) Motor starting voltage check (Requirem ent: The slider starts moving at 1V or less) Procedure:

Apply DC power to DC motor (B170, B180), and while increasing the voltage gradually, ensure that the slider starts moving at 1 V or less.

Invert DC power voltage polarity, and perform the same check as above.

Check the followings if satisfactory results can not be obtained.

- Shaft diameter
- Inside diameter of slider
- Pen drive wire tension
- Gear backlash (motor pinion)

(2) Slip mechanism (Requirement: Motor shaft) does not slip at
Procedure:

Output of 3 V or less	Apply DC power to DC motor (B170, 180), and while increasing the voltage gradually, ensure that the slip mechanism works at 5 V or more but not at 3 V or less.
Output of 5 V or more	Check the followings if satisfactory results can not be obtained.

- Spring length
- Felt thickness
- Gear backlash (motor pinion)
- Pen drive wire tension

(3) Pen drive wire tension check
(Requirement: Slip takes place between gear and pulley.)
Procedure:

When checking the slip mechanism in the preceding adjustment (2) ensure that no slip takes place between pulley and pen drive wire.
* Check the followings if slip takes place between pulley and pen drive wire.

- Spring expansion
- Spring length

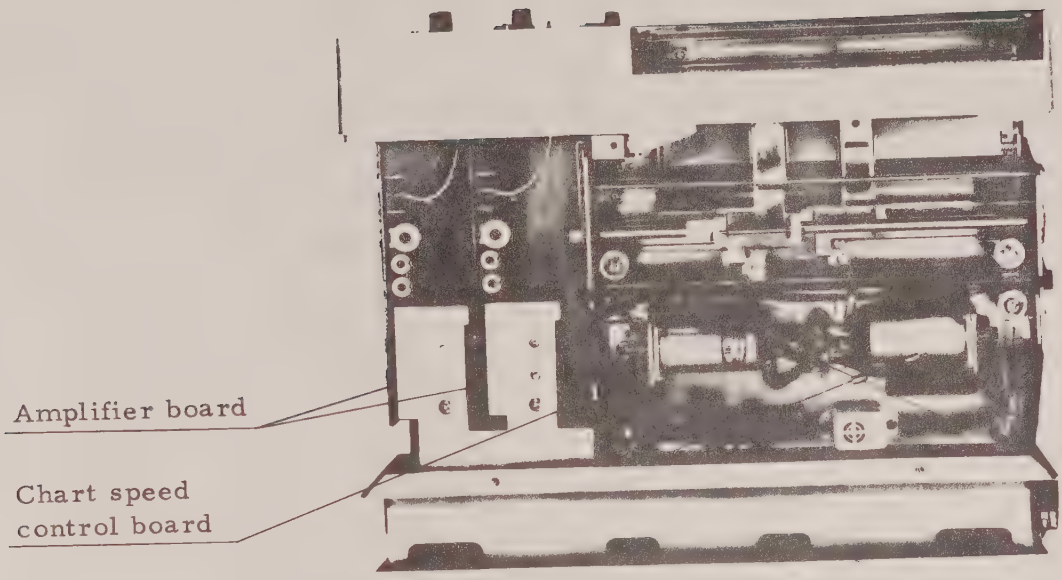
(4) Gear backlash

Requirement: 2 to 6 degrees at the pinion axis (0.1 to 0.3 mm at a tooth face) Hold the motor pinion and engaging gear by fingers, and see how much they wobble.

(5) Pen lift check Procedure:
1) When pens of both channels A and B are lifted their tips should be 1.5 mm or more above the recording paper at both left and right sides.
2) When pen of channel A is at the down position and pen of channel B is at the lifted position, both pens should not touch with each other at both left and right sides.

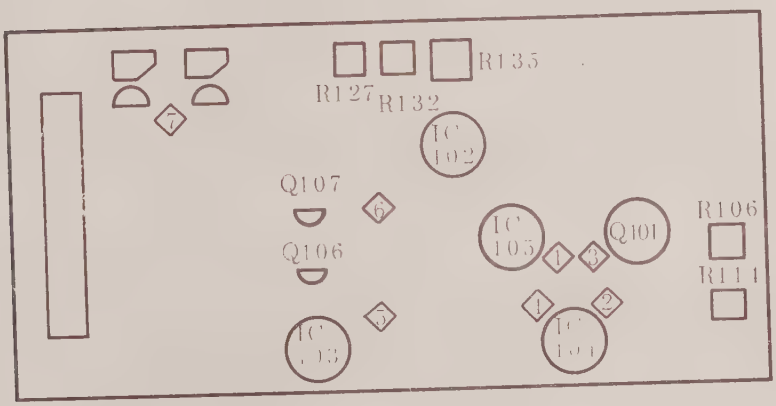
3-2 Servo-amplifier section

(1) Test and adjustment at test points on circuit boards.



VP-6723S (top view)

Adjustment point



Amplifier board test points

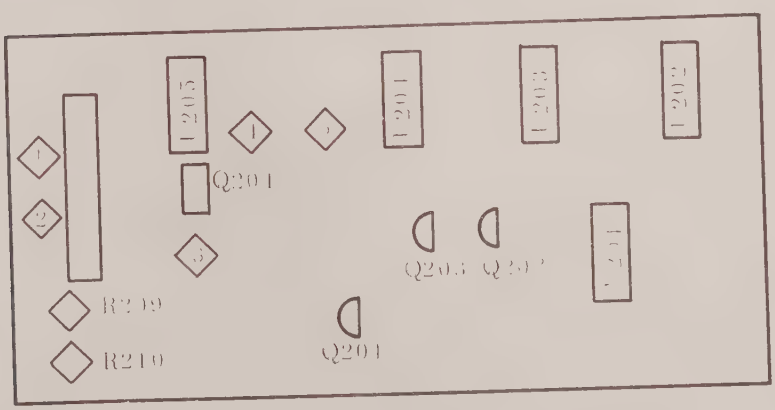


Chart speed control board test points

The voltage at each terminal below is obtained across each test point and the ground terminal on the board.

TP1	DC voltage	+7.8 to +8.8 V (reference voltage)
TP2	Waveform check	(pre-amp output)
TP3		Ground
TP4	DC voltage	-7.7 to -8.7 V
TP5	DC voltage	+15 V (+14.5 to + 16.5 V)
TP6	DC voltage	-15 V (-14.5 to -16.5 V)
TP7	Wabeform check	(main amp output)

(2) Dead band Procedure: Input range setting: 10 and 100mV(or 1 and 10 V)

Set the input setting at 1V position, for example, and the chart feed control to 2 cm/min, as shown in Fig. 1 (a).
Then, apply input voltages as shown in Fig. 3 (b), measure dead band by a record output, and adjust R127 (GAIN ADJ) so that the distance becomes equal to 1.2 mm or less. The sequence of voltage application is as follows:

1) 0.000 V 2) 0.400 V 3) 0.490 V 4) 0.49x V = 0.5 V 5) 0.59 x V 6) 0.590 V 7) 0.500 V

The difference x between the recorded outputs should be measured at when the voltage of 0.500 V is applied at steps 4) and 7).

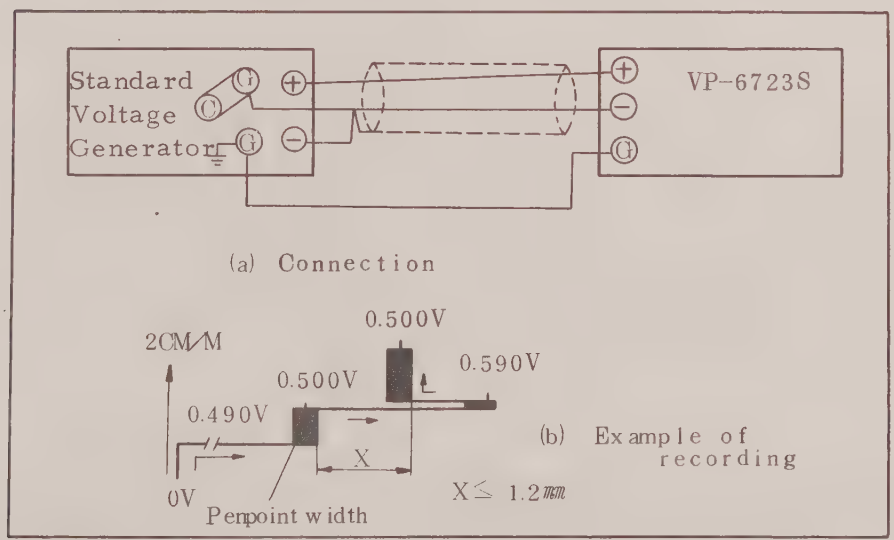


Fig.1

Then, check for other ranges in the same manner to see if the distance x is 1.2 mm or less.

(3) Damping

Input range setting: 1 V

Procedure: Apply a 0.03 Hz square wave from a function generator to the pen recorder, set the recorded waveform amplitude to 0.9Vp-p (90% of full scale) and feed the chart at a speed of 2 cm/min. Then, check the recorded output for $X \leq 1.2$ mm.

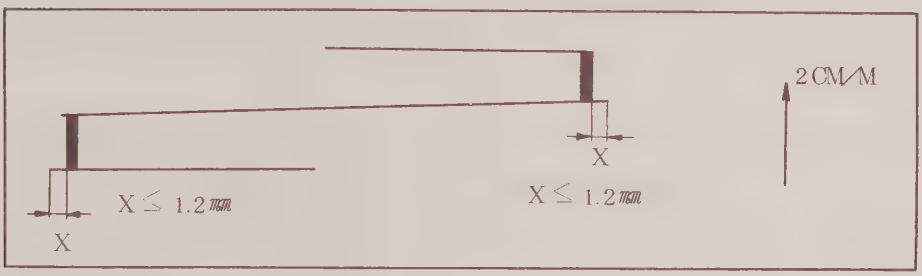


Fig.2

Make the same check on the other ranges.

If above requirement is not satisfied, check the following.

1) Slider movement

2) Value of C107 and C108 capacitor

(4) Zero adjustment between range settings

Input range settings: 10 and 100 mV (or 1 and 10 V)

Procedure: Set a zero point in the middle of the recording with the input setting positioned at 100 mV and the apper feed set at 2 cm/min, paper and record the zero point. Then, switch the input setting to the 10 mV position and adjust the R106 (BALANCE ADJ) so that the zero point coincides with that obtained at the 100 mV position. The distance between the two zero points should be within 0.9 mm. This adjustment should be made after warm-up 30 minutes or more.

(5) Full scale calibration

Input range setting : 1 V

Procedure: Set up a connection as shown in Fig. 3 and set the chart speed to 2 cm/min. Place the pen on the zero line on the recording paper. Then, apply reference a voltage of 1 V from a standard voltage generator to the pen recorder and adjust CAL (R135) so that the pen will deflect to full scale (120 mm).

Note 1): The instrument should be adjusted with a recording paper calibrated with a reference full scale gage.

2): To avoid affect from a dead band, calibration should be made with pen motion restrcited to a single direction.

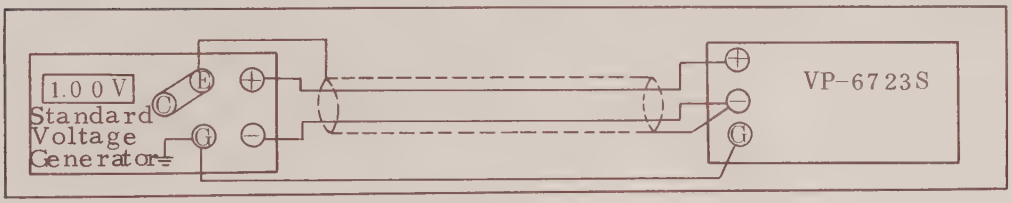


Fig.3

If sufficient calibration is not obtained, check the following diode.

D103 Zener diode 1S2191 (voltage : 7.7 to 8.7 V)

(6) Check on full-scale accuracy (check after full-scale callibration adjustment.)

Input range setting: 10 mV to 10 V

Procedure: Make a setup as shown in Fig. 3 and apply a full-scale voltage to the instrument at each of 10 mV to 10 V range settings. Then ensure that the accuracy of recorded output is within 1.2 mm (±1.0% of 120 mm full scale). If a sufficient accuracy is not obtained, check the followings.

1) R101 (900 kΩ) and R102 (10 kΩ): when accuracy is low at each of 10 mV to 100 mV settings or 1 V to 10 V settings.

2) R109 (2 kΩ), R110 (8 kΩ) and R111 (90 kΩ): when accuracy is periodically low at each of 10 mV, 100 mV, 1 V and 100 V range settings.

(7) Check on VARIABLE control

Input range setting: 10 mV to 100 V

Procedure: Make the same setup as in the preceding check item "Check on full-scale accuracy". Apply a voltage of more than ten times as high as each full-scale voltage (for example, 1 V at 100 mV setting) to the pen recorder and ensure that the pen motion can be variable to the full scale position. After the above check, apply a voltage (for example, 50 mV at 10 mV setting), and ensure that accuracy of ±2 % or better of full scale can be obtained.

(8) Linearity check

Input range setting : 1 V

Procedure: Make a setup as shown in Fig. 3. Apply a step voltage

from a standard voltage generator to the pen recorder as shown in Fig. 4, and measure the difference X between each step voltage and the corresponding scale position on the recording paper. Error d observed at the full scale point should be corrected at each position.

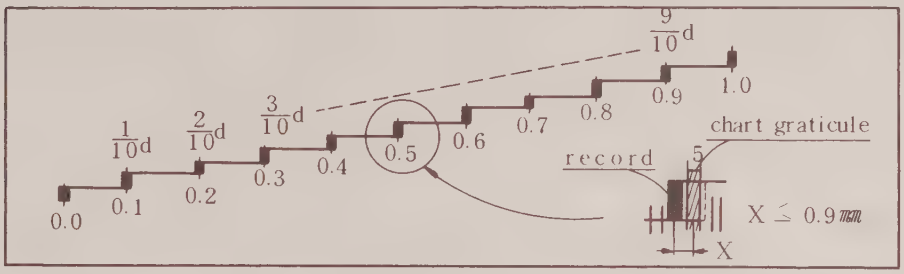


Fig. 4

If a sufficient linearity can not obtained, check the followings.

R102: Potentiometer linearity

U103: Malfunction

(9) 50 mV CAL adjustment

Connect a digital voltmeter to connector pin No. 10 or a lead wire of R131 and adjust R132 for a voltage of 50 mV (±0.1 %).

(10) Pen speed check

Input range setting : 1 V

Procedure: After ensuring that gear setting of chart feeding is correct for the line frequency applied, apply a 0.03 Hz square wave of 1.5 V or more in the same manner as in paragraph (3) but with the chart feed set to 16 cm/min.

Fig. 5

a and b are measured in millimeters.

Pen speed = $\frac{720}{a + b}$ (mm/sec)

(11) Zero Drift (at room temperature or due to temperature drift)

Input range setting: 10 mV

Procedure: Make a setup as shown in Fig. 6 and allow 30 minutes or more for the instrument to warm up. Then, check on zero point shift. (For measurement of zero point shift due to temperature drift: Make the same setup and place it in a thermostatic oven. Then, cause a temperature change of 20°C in the oven and measure a zero point shift (mm). A zero point shift per degree centigrade is given by one twentieth (1/20) of the observed zero point shift (ε).

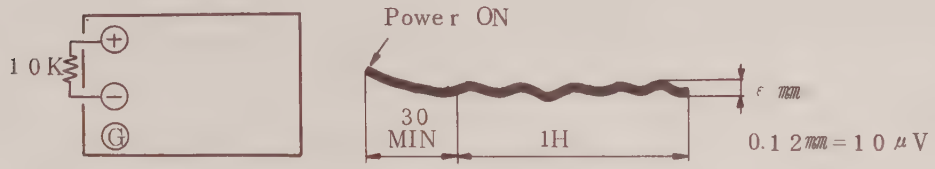


Fig. 6

Zero point shift due to temperature drift ≦ 20 μV/°C

3-3 Chart Speed Controller Section

1) The pulse motor is supplied with current not when the chart speed becomes slow but when the motor has to rotate. This is done at U204 where control sognals generated at U201, Q202 and Q203 are addrd.

2) The pulse motor drive voltage is approx. 8.5 V.

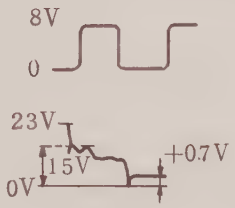
(1) Check on voltage at check terminals on printed-circuit board (referred to ground level 3 in the board)

TP1..... Oscillator output waveform

TP2 ..... D204 Zener voltage

TP4 to 7.. Pulse motor drive

TP8 ..... Pulse motor power supply



(2) Oscillator frequency adjustment

Connect a frequency counter to 1 and set it to PERIOD-B x 100. Push S204 chart speed switch to CM/M, and adjust R209 so that the counter will indicate a period of 4.687 msec or anywhere between (4.678 and 4.698 msec). Then, set the S202 switch to CM/H and adjust R210 so that the period will be 4.395 msec (or anywhere between 4.385, and 4.405 msec).

Also check R and C values since the oscillation frequency changes with R209, R208, and C201 or R210, R211 and C201.

(3) Check on U202

Since U202 is a 12-stage ripple counter, the frequency is divided by two at each of Q1 to Q12. To check this operation, connect a frequency counter across R201 (51 kΩ). Listed at the left are some examples of measured periods. In this case, Q1 to Q6 are used for the /M range settinga and Q7 to Q12 are used for the /H range settings.

Setting	/M	/H
16 ch	9.367 msec	561.7 msec
8 cm	18.74 msec	1124 msec
4 cm	37.47 msec	2247 msec
2 cm	74.54 msec	4494 msec
1 cm	149.9 msec	8986 msec
0.5 cm	299.8 msec	17.97 sec

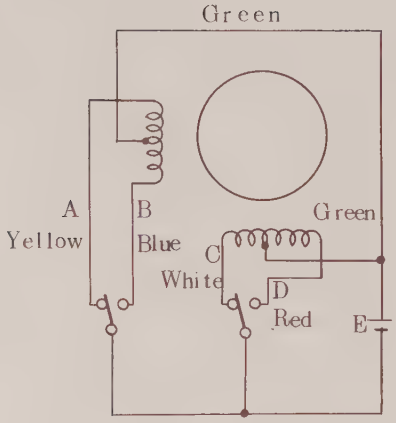
Note: Oscillator output period /M: 4.684 msec
/H : 4.387 msec

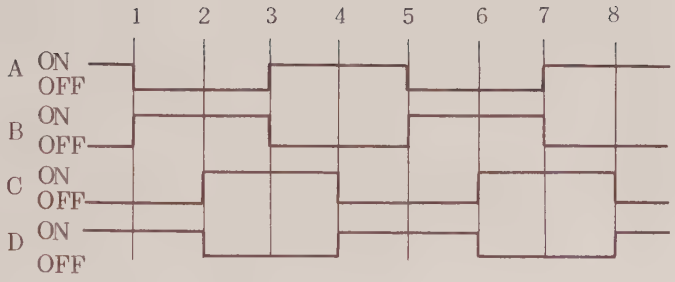
(4) Check on external pulse control circuit

Insert a plug into J201 and connect the plug lead to an oscillator which generates a square wave. The pulse motor should self-start on a square wave up to 300 Hz or less.
The input voltage is at TTL level. Observe a waveform at the Q201 collector. If the pulse motor does not work normally, check D205 (on polarity), Q201, and J201 (for imperfect contact).

(5) Pulse motor

When the pulse motor is connected and driven properly, it will rotate counterclockwise as seen from the axis side. Waveforms as shown below are to be applied to the pulse motor coils.

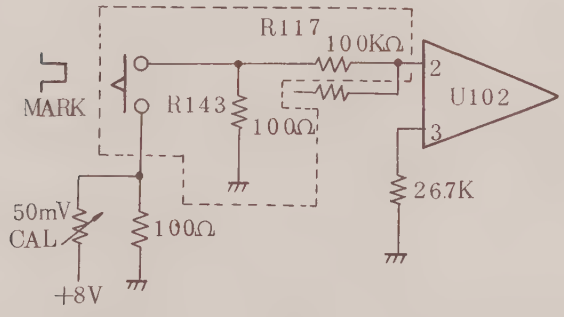




Note: When the pulse motor rotates one step, it causes the chart to proceed 0. 025 mm.

3-4. Marker circuit

When a pushbutton switch on the panel is pressed, the resultant additional DC voltage is applied to the servo-amplifier which will then cause a pen shift (this is known as marker) on the recording paper. In the diagram at left, the marker circuit is enclosed with a dotted line. When a voltage of approx. 25 mV is applied across the input terminals of the pen recorder which is set to 1 V full scale, the pen will deflect approx. 2. 5 mm of full scale (one minimum graduation).



Check: Pushbutton switches S170 and S180 (for imperfect contact)

Resistors R117 and R143 (on resistance value)

3-5 Power Supply Section

(1) Power supply block diagram

AC input
*a

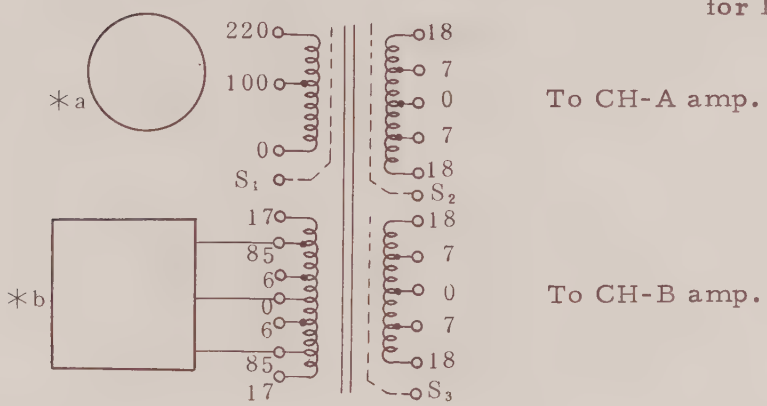
Battery input
control
circuit
*b

To CH-A amp

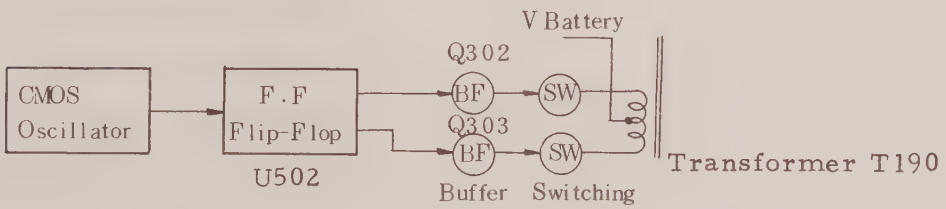
To CH-B amp

1 A Winding marked with *a is used for AC input.

2 A Winding marked with *b and control circuit are used for DC battery input.



(2) Control circuit



A frequency of approx. 1 kHz generated at the CMCS oscillator is devided by two at U502. The resultant frequency passes through buffers and then switching is performed on it. Its voltage is stepped up at the transformer to which a battery voltage is applied at the center tap. The output from the secondary winding is fed to an amplifier, a pulse motor, and etc.

Power source	Battery	Voltage change
Internal battery	Alkaline, Ni-Cd	7 V to (10 V)
External battery	12 V	11 to 15 V (centering on 13.5 V)
	24 V	22 to 30 V (centering on 27.0 V)

The Q301 and Q305 V_{CE} should be 1 V or less when saturated.

(3) Battery alarm LED circuit

a) Internal battery

When alkaline or batteries are used as internal power source, if their voltage decreases to approx. 7.2 V, an LED on the panel lights up. If the voltage is above 7.2 V, the LED flickers when the pulse motor rotates at low speeds. For Ni-Cd batteries, the LED lights up when the voltage decreases to approx. 8.8 V.

b) Charge

When Ni-Cd batteries are charged to 11.3 V, the LED will go off to indicate full charge.

c) If batteries of 24 V or more are connected to the battery connection terminals when the EXT DC source is set to 12 V range, the LED lights up and the buzzer rings.

d) Check on charging current

Connect a voltmeter across R192 (68Ω) and ensure that it reads 24 V or less (or 350 mA or less).
Required charging time is typically 15 hours.

(4) Power source and required current

Power source type	Voltage	Required current (approx.)		Remarks
		Balanced	Unbalanced	
Ni-Cd (NR-D)	10 V	0.34 A	0.76 A	*
	9 V	0.34 A	0.69 A	0.42A
External battery (12 V)	11 V	0.51 A	0.92 A	
	13.5 V	0.65 A	1.1 A	
	16 V	0.69 A	1.2 A	
External battery (24 V)	22 V	0.33 A	0.56 A	
	27 V	0.37 A	0.62 A	
	32 V	0.4 A	0.67 A	

Mn	10 V 8 V 7 V	0. 55 A 0. 51 A 0. 45 A	1. 2 A 1. 1 A 0. 9 A	* 0. 39 A

Note:

1) These values are measured for a chart speed of 16 cm/min.

2) Presented in the remarks column are typical required currents in recording a sine wave of 0. 01 Hz at a chart speed of 4 cm/hour.

3) The minimum operating voltage (on which the instrument should operate normally) of each type of batteries is as follows:

Ni-Cd	9 V
Mn	7 V
12 V battery	11 V
24 V battery	22 V

3-6 Miscellaneous

(1) Check on insulation resistance between the power cord and cabinet

Procedure: Make a setup as shown in Fig. 7. Insulation resistance 10 MΩ/500 V DC

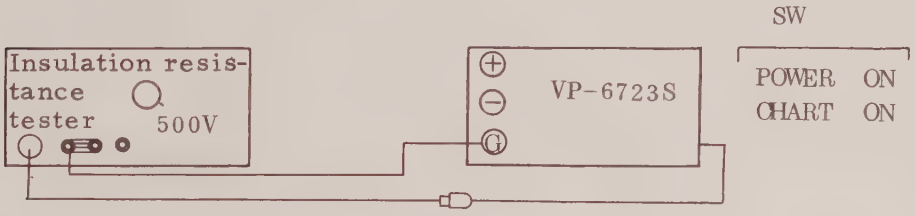


Fig.7

The insulation resistance may change with ambient temperature and heat run time; however, it should meet the above requirement. Otherwise check on the following components.

Power transformer T101

Power switch SW104

Filter (L190, C190) terminal strips

(2) Check on insulation resistance between the cabinet and an input terminal.

Procedure: Make a setup as shown in Fig. 8.
10 MΩ/250 V DC (for either of the + and - terminals)

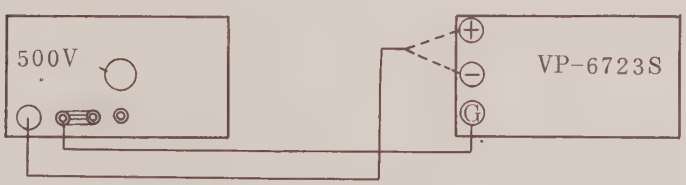


Fig.8

Note 1 ZERO switch should be set to RECORD.
2 Power cord should be disconnected.

If the insulation resistance measured does not meet the requirement described above, check the following items.

C170, C180 .... Insulation resistance

T101	Insulation resistance between the cabinet and secondary winding
R170, R180....	DC servometer insulation

(3) Check on power consumption

Input range setting: 1 V

Procedure:

1) Balanced: Place the pen at the center and set the chart feed switch to ON. Under this condition, ensure that the power consumption is 15 VA or less.

2) Unbalanced: Apply a DC voltage of 2 V (over full scale) to the instrument with gear slipping and set the chart feed switch to ON. Under this condition, ensure that the power consumption is 20 VA or less.

(4) Voltage test

1) Apply an AC voltage (50 Hz) across the power cord and ground terminal and increase it gradually to 1.5 kV. The instrument should work normally after it has undergone that voltage for one minute.

2) If the instrument fails to work normally, check the following components on insulation resistance.

Power transformer T101

Power switch SW104

Filter (L190, C190) terminal strips

Section 4 MAINTENANCE

1. Potentiometer cleaning

When the recording curve always shows irregular movement at the same position, and when turning of the zero adjustment knob produces the same movement, execute potentiometer cleaning according to the following sequence (see Fig. 3-1).

① Remove the top cover.

② Moisten a cloth with alcohol and lightly wipe the potentiometer 2 or 3 times.

③ Any dirt on the contacts should be removed.

④ After the cleaning, apply grease (special potentiometer grease, optionally supplied) thinly to the potentiometer.

Inquire at the service station for grease.

2. Dirt on the outer case

Use soap water to wipe off external dirt

Note: Thinner, benzine, and other organic solvents may not be used.

3. Life of the parts

The expected life of the main parts used in this instrument is as follows.

Potentiometer:	100,000 times
Servo-motor:	2000 hours
Slide wire:	1,000,000 times

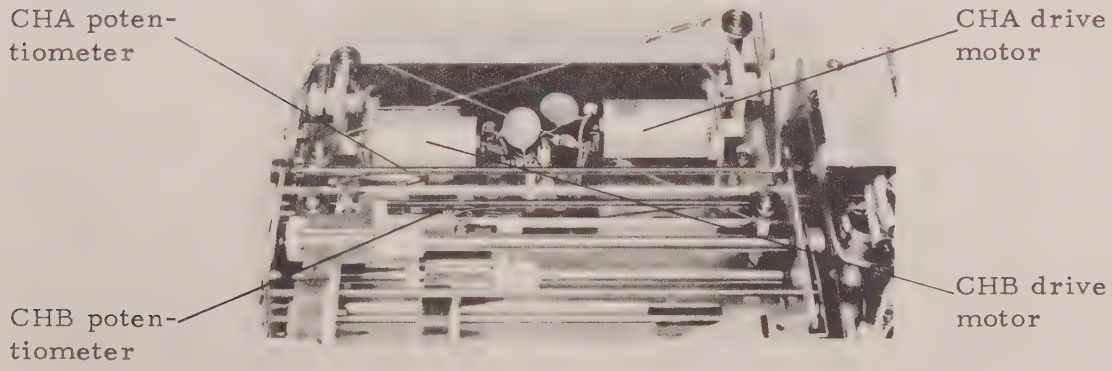


Fig. 3-1

Amplifier

Ref No.	Code No.	Description			
		Resistors			
R101	808 995 070	990KΩ	0.25%		Metal film
R102	808 995 390	10KΩ	0.25%		Metal film
R103	808 533 100	10KΩ	5%	1W	Metal oxide
R104, 105	806 622 200	20KΩ	1%		Metal film
R106	818 690 540	50Ω			Carbon trimmer
R107	806 622 200	20KΩ	1%		Metal film
R108	807 242 820	8.2KΩ	5%	1/8W	Carbon
R109	808 995 040	2KΩ	0.25%		Metal film
R110	808 995 400	8KΩ	0.25%		" "
R111	808 995 380	90KΩ	0.25%		" "
R112	807 240 470	47Ω	5%	1/8W	Carbon
R113	807 442 100	1KΩ	5%	1/2W	"
R114	818 692 750	5KΩ			Carbon trimmer
R115	807 441 820	820Ω	5%	1/2W	Carbon
R116	806 620 392	392Ω	1%	1/4W	Metal film
R117	806 622 475	47.5KΩ	1%	1/4W	" "
R118	806 623 178	178KΩ	1%	1/4W	" "
R119	806 514 100	1MΩ	1%	1/2W	" "
R120	806 622 267	26.7KΩ	1%	1/4W	" "
R121	807 242 470	4.7KΩ	5%	1/8W	Carbon
R122, 123	807 243 100	10KΩ	5%	1/8W	"
R124, 125	808 870 100	10Ω	5%	2W	Metal oxide
R126	806 621 825	8.25KΩ	1%	1/4W	Metal film
R127	818 692 410	2KΩ			Carbon trimmer
R128					
R129					
R130					
R131	806 620 100	100Ω	1%	1/4W	Metal film
R132	818 690 520	5KΩ			Carbon trimmer
R133	806 622 150	15KΩ	1%	1/4W	Metal film
R134	806 621 510	5.11KΩ	1%	1/4W	" "
R135	818 723 070	5KΩ			Carbon trimmer
R136	819 990 270	5KΩ			Carbon VR
R137, 138	806 622 221	22.1KΩ	1%	1/4W	Metal film
R139	807 242 470	4.7KΩ	5%	1/8W	Carbon
R140, 141	806 622 221	22.1KΩ	1%	1/4W	Metal film
R142	806 623 100	100KΩ	1%	1/4W	" "
R143	806 620 100	1KΩ	1%	1/4W	" "
R151	807 440 820	82Ω	5%	1/2W	Carbon film
R152, 153	807 362 750	7.5K	5%	1/4W	Carbon film
R154	807 441 100	100Ω	5%	1/2W	Carbon film

Ref No.	Code No.			Description
		Capacitors		
C102, 103	827 900 520	1μF	100V	Metalized film
C104, 105	823 400 180	56pF		Ceramic
C106				
C107, 108	820 075 090	1μF	50V	Electrolytic
C109, 110	823 400 180	56pF		Ceramic
C111				
C112, 113	820 004 580	100μF	35V	Electrolytic
C114, 115	820 003 110	1000μF	16V	"
		Diodes		
D101, 102	774 000 492	RD6AN2	250mW	Zener VZ=5.8-6.4V
D103	775 001 130	1S-2191	250mW	" VZ=7.8-8.8V
D104	775 001 090	WZ-081	500mW	" VZ=7.7-8.5V
D105, 106	775 001 260	WZ-071	"	" VZ=6.7-7.5V
D107, 108	775 001 170	WZ-162	"	" VZ=15.4-17.1V
D109	772 000 890	SV-03C		Silicon
D110	772 000 900	SV-04C		"
D111	772 000 890	SV-03C		"
D112	772 000 900	SV-04C		"
		Transistors		
Q101	769 001 260	2SK18A-O		FET Dual
Q102	762 828 120	2SC 828ARS		NPN
Q103	764 122 640	2SC1226AQR		"
Q104	760 564 110	2SA564ARS		PNP
Q105	760 699 130	2SA699AQR		PNP
Q106	760 150 910	2SC1509RS		NPN
Q107	760 777 010	2SA777RS		PNP
		IC		
U101 - 104	769 500 560	μPC157A		
		Switches		
S102	873 002 291	Push switch		ZERO/RECORD
S103	873 002 300	" "		RANGE Select

Ref No.	Code No.	Description
		Connectors
	911 001 480	15 pins
	911 001 490	15 pins
		PC Board
	973 068 320	PC Board

Chart Speed Control

Ref No.	Code No.				Description
		Resistors			
R201	807 243 510	51KΩ	5%	1/8W	Carbon
R202	807 244 100	100KΩ	5%	1/8W	"
R203	807 243 120	12KΩ	5%	1/8W	"
R204	807 243 220	22KΩ	5%	1/8W	"
R205					
R206	807 243 100	10KΩ	5%	1/8W	"
R207	807 243 220	22KΩ	5%	1/8W	"
R208	806 623 178	178K	1%	1/4W	Metal film
R209, 210	819 905 080	50KΩ			Trimmer potentiometer
R211					
R212	806 643 402	402KΩ	1%	1/2W	Metal film
R213					
R214	807 591 522	2.2MΩ	5%	1/4W	Metal
R215	807 243 220	22KΩ	5%	1/8W	Carbon
R216	807 243 330	33KΩ	5%	1/8W	"
R217	807 441 560	560Ω	5%	1/2W	"
R218	807 442 100	1KΩ	5%	1/2W	"
R219	807 441 330	330Ω	5%	1/2W	"
R220 - 223	807 243 470	47KΩ	5%	1/8W	"
R224	807 442 220	2.2KΩ	5%	1/2W	"
		Capacitors			
C201	826 920 490	0.01μF			Polystylen
C202	825 131 540	0.015μF		50V	Polyester film
		Diodes			
D201 - 204	772 000 870	V06B			Silicon
D205	775 001 240	1S953			"
D206, 207	775 001 270	WZ-090			Zener VZ=8.5-9.5V
D208 - 211	772 000 870	V06B			Silicon
D212	776 000 170	TLG-103			Light Emitting Diode
		Transistors			
Q201 - 203	762 828 120	2SC828ARS			NPN
Q204	763 389 010	2SD389			"

Ref No.	Code No.	Description		
		IC		
U201	769 500 860	µPD4001C		MOSIC
U202	769 521 060	MC14040CP		"
U203	769 500 880	µPD4027C		"
U204	769 500 860	µPD4001C		"
		Capacitors		
C201				
C202	825 131 540	0.015µF	50V	Polyester
C203	825 141 040	0.1µF	50V	"
C204	820 075 090	1µF	50V	Electrolytic
C205	820 004 580	100µF	35V	"
C206	820 005 090	220µF	35V	"
C207	820 004 580	100µF	35V	"
		Switches		
S201	803 002 410			Push switch
S202	803 002 420			" "
		Motor		
B201	928 100 200	SP4-415140-150		Pulse motor
		Connector		
	911 001 340	10 pins		
	911 001 350	10 pins		
J201	910 000 350	X-G8010		Jack
P201	910 000 360	S-H5004		Plug
		PC Board		
	972 045 220	PC Board		

Main Frame

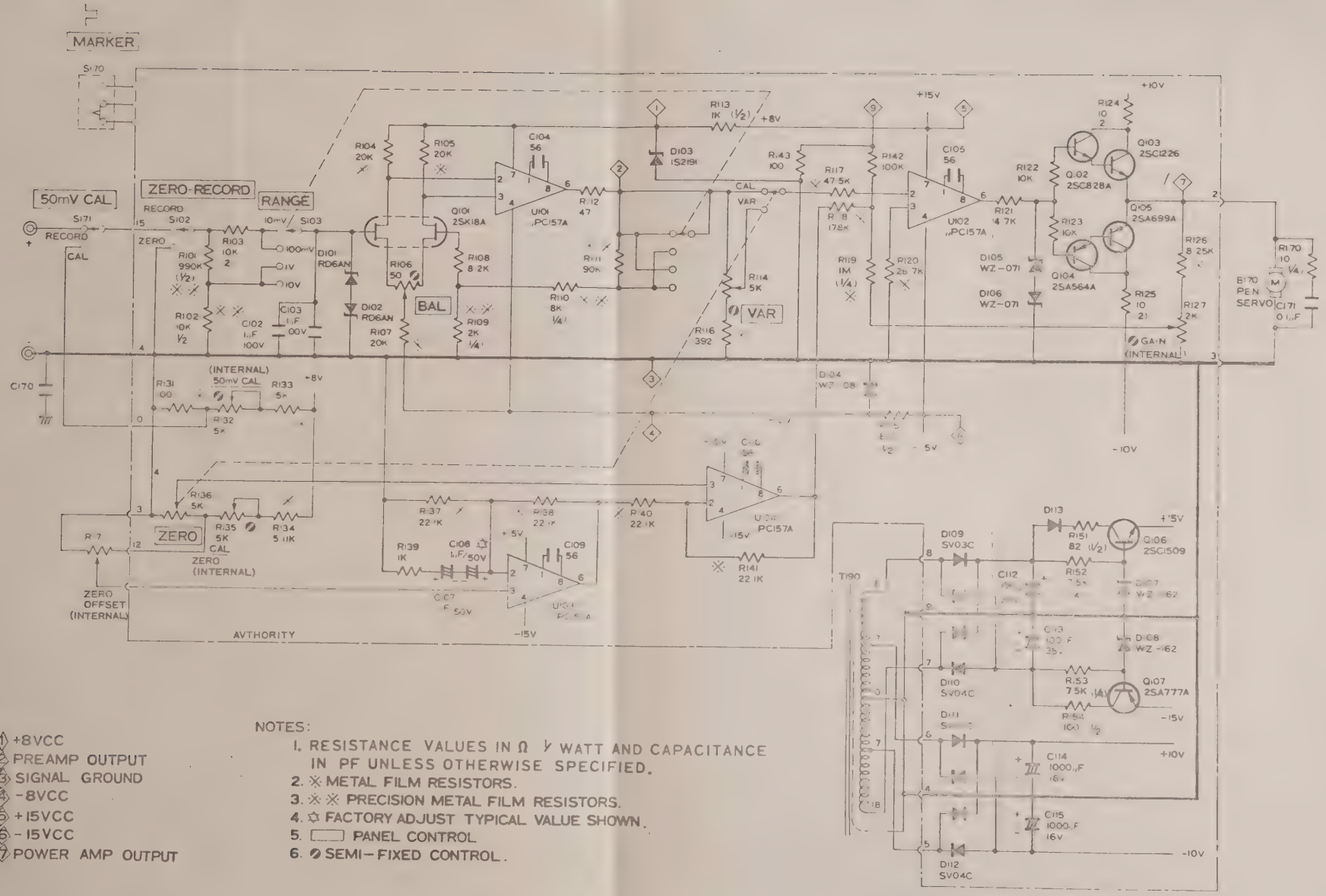
Ref No.	Code No.	Description			
		Resistors			
R170	807 360 100	10Ω	5%	1/4W	Carbon
R171	819 904 390	Potentiometer			
	819 904 400	Potentiometer contact			
R180	807 360 100	10Ω	5%	1/4W	Carbon
R181	819 904 390	Potentiometer			
R190	807 441 470	470Ω	5%	1/2W	Carbon
R191	808 531 270	270Ω	5%	1W	Metalized oxide
R192		68Ω	5%	10W	
		Capacitors			
C170	827 900 570	0.047μF		600V	Metalized film
C171	823 511 070	0.1μF			Ceramic
C180	827 900 570	0.047μF		600V	Metalized film
C181	823 511 070	0.1μF			Ceramic
C190	823 580 040	0.0047μF			Ceramic
C195	827 900 570	0.047μF		600V	Metalized film
		Diodes			
D190	772 000 870	V06B			Silicon
D191	776 000 170	TLG-103 (Green)			LED
D192	772 000 860	S3G1			Silicon
D193	776 000 160	LN21 (Red)			LED
D194	774 000 730	RD16FB			
D195, 196	775 001 240	1S953			Silicon
		Switches			
S170, 180	873 000 850	Push switch			Marker
S171, 181	872 000 890	Slide switch			Record/50mV Cal
S190	871 000 770	Toggle switch			Power
S191	871 000 770	Toggle switch			Chart
S192	870 902 700	Rotary switch			Power select
S195	872 000 900	Slide switch			Ni-cd/Mn
		Transformer			
T190	850 002 950				

Ref No.	Code No.	Description
		Motors
B170, 180	925 300 040	Servo motor
		Coil
L190	857 409 050	Filter coil
		Connector
J193	911 100 850	1-480305-0 (AMP)
P193	911 100 860	1-480303-0 (AMP)
	911 100 880	Pin
	911 100 870	Socket
	890 400 100	Battery case Type 14-1
	860 000 230	Micro Buzzer
		Power cable
	891 000 030	Fuse SC-315 MA
	891 600 300	Fuse holder
	891 600 310	Fuse holder cap
J170, 171, 180, J181, 191, 192	895 500 020	Input terminal
	241 000 010	Input terminal spacer(Red)
	241 000 040	" (Black)
	264 430 890	Earth terminal

Power Supply

Ref No.	Code No.				Description
		Resistors			
R301	807 441 100	100Ω	5%	1/2W	Carbon
R302	807 442 220	2.2KΩ	5%	1/2W	"
R303	807 244 180	180KΩ	5%	1/8W	"
R304	807 243 910	91KΩ	5%	1/8W	"
R305, 306	807 243 390	39KΩ	5%	1/8W	"
R307, 308	807 361 510	510Ω	5%	1/4W	"
R309					
R310	807 442 240	24KΩ	5%	1/2W	"
R311	807 441 680	680Ω	5%	1/2W	"
R312	807 243 220	22KΩ	5%	1/8W	"
R313	807 442 240	2.4KΩ	5%	1/2W	"
R314	808 532 100	1KΩ	5%	1W	Metalized oxide
R315	807 243 220	22KΩ	5%	1/8W	Carbon
		Capacitors			
C301	820 074 570	47μF	35V		Electrolytic
C302	825 131 040	0.01μF	50V		Polyester
		Diodes			
D301	775 001 270	WZ-090		500mW	Zener VZ=8.5-9.5V
D302-305	772 000 980	V09C			Silicon
D306	774 000 720	RD-36FBD		1W	Zener VZ=37-41V
D307	775 001 710	XZ-082		500mW	Zener VZ=7.95-8.45V
D308	775 001 510	XZ-066		500mW	Zener VZ=6.4-6.8V
D309	775 001 700	XZ-107		500mW	Zener VZ=10.4-11.1V
D310-313	772 000 870	V06B			Silicon
		Transistors			
Q301	764 156 710	2SC1567			NPN
Q302, 303	762 828 120	2SC828ARS			NPN
Q304, 305	764 176 800	2SC1768			NPN
Q306, 307	762 828 120	2SC828ARS			NPN
		IC			
U301	769 500 860	uPD4001C			MOS
U302	769 515 010	DN819			
		Connector			
P301	911 001 760	15 pins			
	911 001 490	15 pins			

Ref No.	Code No.	Description
F301, 302	891 600 350	SN-5053
	891 000 060	SC2A
	891 000 040	SC500mA
E301	973 078 610	PC Board



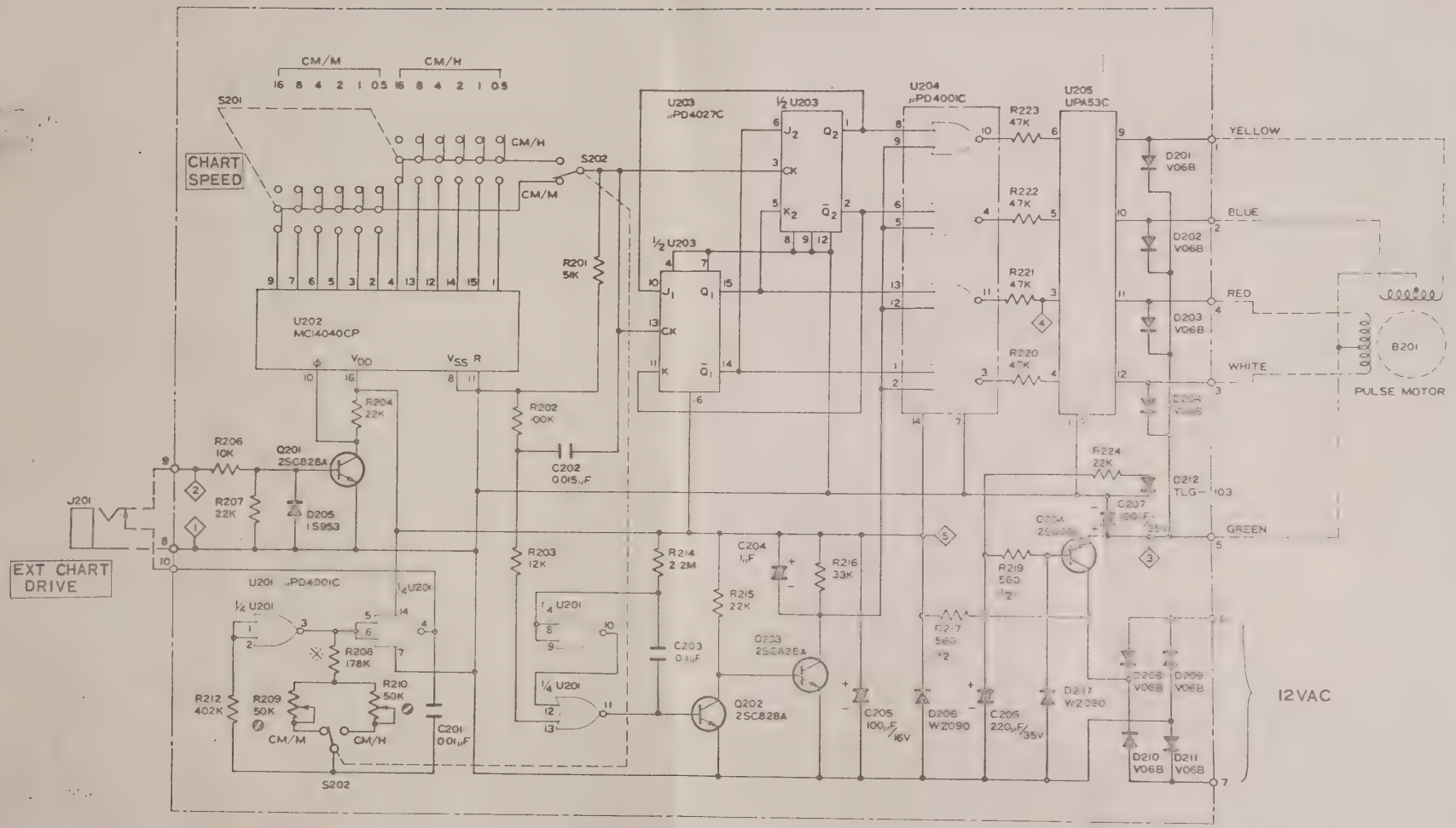
1. +8VCC
2. PREAMP OUTPUT
3. SIGNAL GROUND
4. -8VCC
5. +15VCC
6. -15VCC
7. POWER AMP OUTPUT

NOTES:

1. RESISTANCE VALUES IN Ω ¼ WATT AND CAPACITANCE IN PF UNLESS OTHERWISE SPECIFIED.
2. ※ METAL FILM RESISTORS.
3. ※※ PRECISION METAL FILM RESISTORS.
4. ☼ FACTORY ADJUST TYPICAL VALUE SHOWN.
5. ▭ PANEL CONTROL
6. ⌀ SEMI-FIXED CONTROL.

SCHEMATIC DIAGRAM

SERVO AMPLIFIER



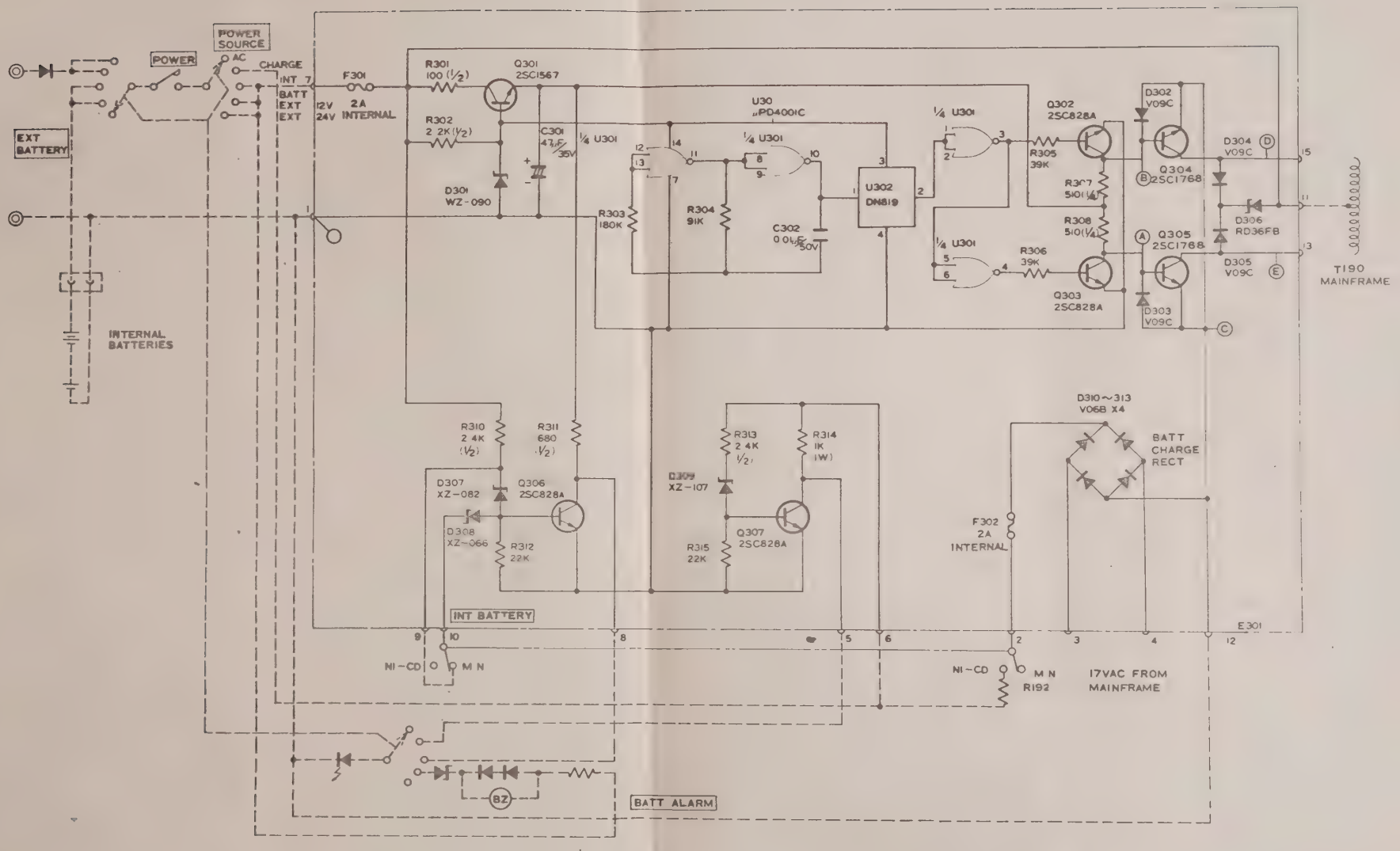
NOTES

1. RESISTANCE VALUES IN Ω ⅛ WATT AND CAPACITANCE IN PF UNLESS OTHERWISE SPECIFIED.
2. ※ METAL FILM RESISTER.
3. ⊘ SEMI-FIXED CONTROL.

① PULSE INPUT, VDD ETC GROUND
② PULSE INPUT, HIGH
③ REGULATED DC FOR PULSE MOTOR
④ PULSE MOTOR DRIVE PULSE
⑤ REGULATED +VDD, ETC

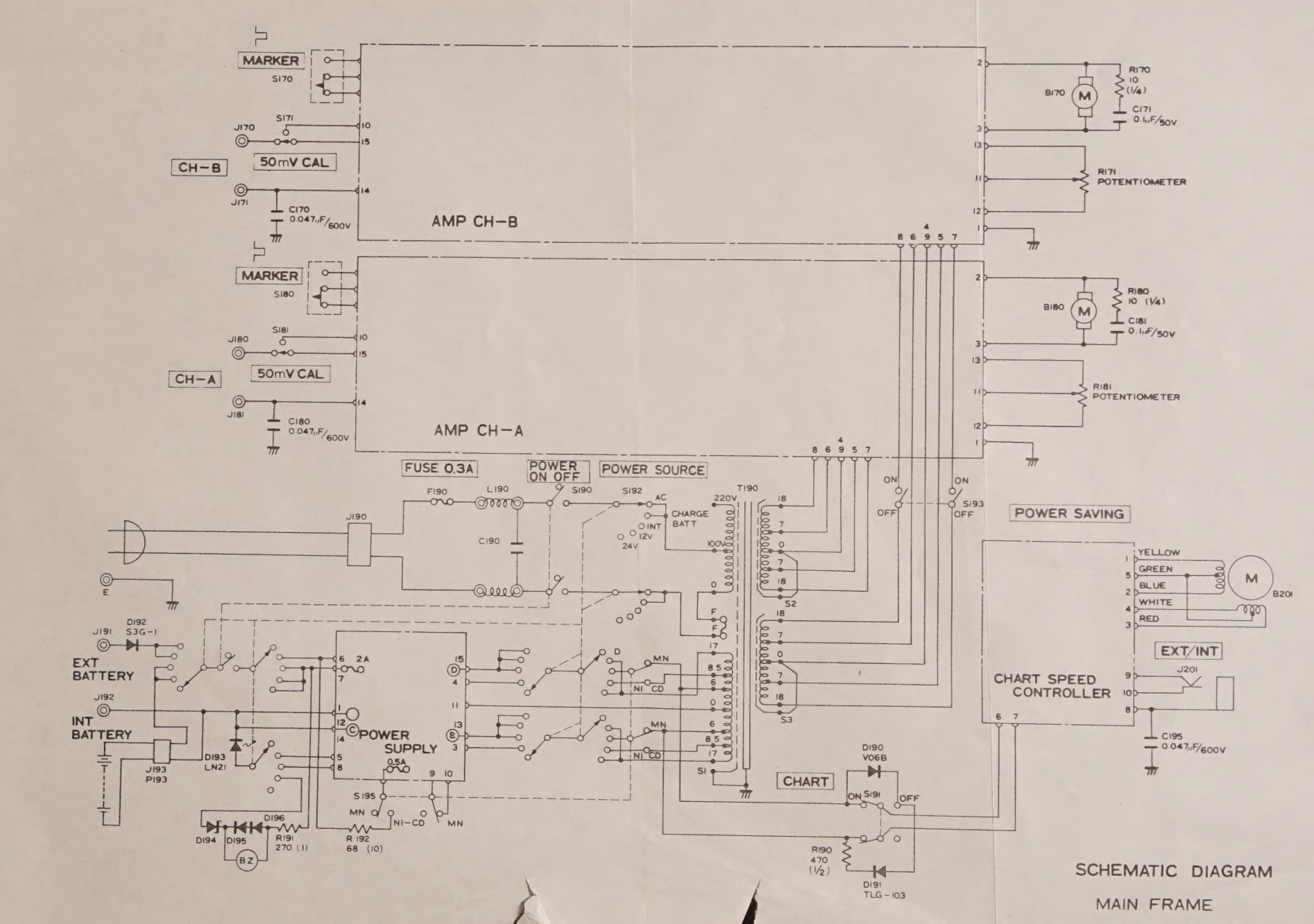
SCHEMATIC DIAGRAM

CHARTSPEED CONTROL



1. RESISTANCE VALUES IN Ω 1/8 WATT AND CAPACITANCE IN PF UNLESS OTHERWISE SPECIFIED.

SCHEMATIC DIAGRAM
POWER SUPPLY


MARKER
S170
J170
S171
CH-B
50mV CAL
J171
C170
0.047μF/600V
AMP CH-B
B170
R170
10
(1/4)
C171
0.1μF/50V
R171
POTENTIOMETER
MARKER
S180
J180
S181
CH-A
50mV CAL
J181
C180
0.047μF/600V
AMP CH-A
B180
R180
10 (1/4)
C181
0.1μF/50V
R181
POTENTIOMETER
FUSE 0.3A
POWER ON OFF
POWER SOURCE
F190
L190
S190
S192
AC
CHARGE BATT
INT
12V
24V
C190
J190
T190
220V
S193
POWER SAVING
YELLOW
GREEN
BLUE
WHITE
RED
M
B201
EXT/INT
J201
CHART SPEED CONTROLLER
C195
0.047μF/600V
EXT BATTERY
INT BATTERY
J191
D192
S3G-1
J192
J193
P193
D193
LN21
2A
POWER SUPPLY
0.5A
S195
MN
NI-CD
D194
D195
D196
R191
270 (1)
R 192
68 (10)
BZ
CHART
D190
V06B
S191
R190
470
(1/2)
D191
TLG-103
S2
S3
SI
SCHEMATIC DIAGRAM
MAIN FRAME